Security for the Members of Defined Benefit Pension Schemes

by

Deborah Cooper

Actuarial Research Paper No. 126

July 2000

ISBN 1 901 615 45 4

"Any opinions expressed in this paper are my/our own and not necessarily those of my/our employer or anyone else I/we have discussed them with. You must not copy this paper or quote it without my/our permission".

Security for the Members of Defined Benefit Pension Schemes[1]

Deborah Cooper
Department of Actuarial Science and Statistics
City University

June 2000

[1] This paper was financed by a Research Grant from the Institute of Actuaries.

1 Introduction

This paper is mainly concerned with ways of reducing the risks faced by members of defined benefit pension schemes in the event that the sponsoring employer becomes bankrupt at a time when the pension scheme has insufficient assets to secure its wind up benefits.

Within the EU, there are four main alternative methods of defined benefit pension provision, each giving rise to different concerns with security:

1. the 'Anglo Saxon' model, as in the UK;
2. the book reserve arrangement;
3. arrangements which are regulated similarly to insurance companies;
4. the French Pay as You Go (PAYGo) system.

Schemes funded through insurance contracts properly fall into the first category, and are different to schemes regulated as insurance companies.

In some ways the first three models are comparable, and only the latter is significantly different. Book reserved schemes can be thought of as extreme examples of funded schemes, either as having 100% self-investment in the sponsoring employer; or with a 0% funding level. However, because it is these very extremes that give rise to risk in the event of employer insolvency, they give rise to different regulatory solutions. Similarly, regulating a scheme as an insurance company does not obviate the need for funding, it merely imposes different costs.

The French system of occupational pension provision mirrors most closely the commonly accepted form of state provision, with security issues met through a pooling of risks between employers and across industries. Here, if an employer becomes bankrupt, the costs of the accrued pensions of the employees will be met by the other participating employers, giving rise to a potential for massive cross subsidy.

In a 'free market', with perfect knowledge, there should be no need for external measures to provide security for members of defined benefit pension schemes in the event of their employer's insolvency. Employees would know and understand the nature of the risk faced if their employer's future was financially uncertain, and would react by demanding higher wages than from an otherwise equivalent employer. Effectively, employees would discount the risk faced by their employer's likely bankruptcy, and demand an additional wage to compensate them for the risk.

We do not operate in such a free market. Most employees cannot dictate their terms to an employer, and in any case would have difficulty in assessing their employer's risk of bankruptcy (with the exception, perhaps, of very large companies that are rated by external agencies). They would also have difficulty in assessing an appropriate level of compensation for the risk they face. Instead, governments issue legislation aimed at controlling the risks faced by members of defined benefit pension schemes. However, there is a fine balance to be struck, since excessive regulation can introduce new problems and hamper the development of appropriate retirement provision. In addition, government regulation can act in contrary directions. Government departments responsible for pension provision will be concerned with improving access and security for individual scheme members, whereas those responsible for finance will be concerned with minimising revenue loss.

The most secure alternative to government intervention in the pensions industry is for pensions to be provided through private insurance markets. However, this level of security is only achieved at a price. Either due to the absence of sufficiently sophisticated employees, or because employees do not feel the cost is justified, occupational pension scheme sponsors have shown themselves reluctant to pay this price.

The role supplementary pension schemes play in relation to government policy will affect what might be considered an appropriate level of regulation. If it is compulsory for employers to provide a pension scheme then, although additional regulation might have unfortunate economic consequences, it cannot be avoided except by ceasing business. If, on the other hand, pension provision is voluntary, as is the case in the UK, employers can respond to additional regulatory burdens by ceasing to provide a pension scheme. Thus a measure to provide more security to employees in the event of one contingency (insolvency of the employer) could reduce the level of security in the event of another, more likely, contingency (retirement).

Similarly, government intervention might be more or less appropriate depending on the role the pension scheme fulfils in relation to state provision. For example, most countries provide state pensions at a minimal level at least (the 'first pillar'), since there are certain groups for which financial markets cannot successfully provide pensions. In addition, many governments ensure that, for those who have relied on their own earnings throughout their working lifetime, there are also salary related retirement incomes. This provision can be made by compulsory occupational pension schemes (for example, in France) or by additional state provision (for example, in the UK). However, whilst the benefits provided by the first pillar of provision are fairly comparable across most countries, this second pillar varies considerably. In those countries where the government has legislated for a 'reasonable' level of provision, one might argue that there is less cause for intervention in private provision above that level.

On the other hand, if private provision is a substitute for state provision (for example, in the UK to the extent of the Guaranteed Minimum Pension in those schemes contracted out of the State Earnings Related Pension Scheme), or if state provision stops at a low level, it is more reasonable to justify intervention.

When a defined benefit pension scheme's sponsoring employer becomes bankrupt, in addition to the risks of non-payment of contributions and misappropriation of funds, there is also the risk that there are insufficient assets to secure the expected benefits[2]. This can arise due to historic underfunding, or due to unanticipated poor experience, including poor investment returns. Insolvency insurance can compensate for these risks, whereas more general forms of regulation are aimed at avoidance of the first two risks, and a reduction of the third. They can also be used to reduce the cost of insolvency insurance.

Only a small number of countries in the EU have compulsory insolvency insurance, and in most cases its cover is limited to those pension arrangements that are funded

[2] The former two risks are also faced by defined contribution schemes, but the third is not, unless the scheme guarantees minimum rates of investment return.

through book reserves[3]. In all cases the insurance only applies to plan terminations that arise as a result of the sponsoring employer's bankruptcy and, whilst the insurance is often provided by private sector companies, in no case is the premium calculated on a wholly market related basis.

When premiums are not directly risk related, insurance can introduce selection problems. For example, where a pension scheme's liabilities are backed by explicit investment funds, the premium for insolvency insurance should be related to the size of the unfunded liability, otherwise employers have less incentive to fund the scheme adequately. The premium should also be related to the company's credit rating. Regulation, which might already be in place, can be adopted to protect the insurer against the risk of adverse selection. However, it is probably true that the risk cannot be removed entirely, since even market priced premiums are likely to involve elements of approximation. The most common forms of regulation are:

1. regulating the establishment of an occupational pension scheme, for example, in the UK new pension schemes have to obtain approval from the Inland Revenue and approved schemes must be established under Trust Law;
2. ongoing regulation of the scheme, for example, in the UK approved schemes must publish annual accounts and meet certain minimum funding requirements ;
3. involvement of skilled professionals, for example, in the UK a Fellow of the Institute or Faculty of Actuaries who is also a Scheme Actuary must be responsible for the scheme valuation;
4. disclosure requirements, for example, in the UK there is a prescribed minimum amount of information that must be given to scheme members when joining the scheme, and at regular intervals thereafter;
5. establishment of a fund of assets, for example, in the UK, in order for pension schemes to qualify for tax relief, contributions must be made to an approved scheme and they must be invested separately from the employer, under Trust Law.

The examples given here are all UK specific, and there are clearly several ways in which each target can be achieved.

In the next section these strategies are considered, with particular reference to how they can protect the security of members of funded defined benefit pension schemes.

2 Funded Pensions Schemes

It is generally accepted that the insurance market provides the 'gold standard' for security. Throughout the developed world, individuals taking out insurance policies, whether for life or personal goods cover, do so with the full expectation of receiving the benefit specified in their policy document. This level of security comes at a cost. For example, insurance companies have to fulfil stringent disclosure requirements; they must establish solvency margins in addition to the expected value of their liabilities; their freedom of action in satisfying regulatory requirements is curtailed; and they have to provide their shareholders with a profit.

Members of pension schemes do not generally have such a high degree of security. One problem arises since, whilst defined benefit schemes have rules that set out the benefits members are entitled to under various contingencies, members'

[3] The various types of compulsory insolvency insurance schemes, with a brief description of minimum funding tests, found in the EU and USA are described in the appendix.

'expectations' often centre on remaining in employment until retirement, and so can be significantly different. In particular, when an employer becomes insolvent, even if there is not a shortfall of assets in the pension fund, members' expectations will often be significantly different to the eventual benefit they receive. This represents a misunderstanding of a pension scheme's ability to provide, which could lead to poverty in retirement. In this instance, better disclosure could reduce the risk that employees under save too little because they overestimate the pension scheme's ability to provide in all circumstances.

If a pension scheme has been regulated as an insurance company then the scheme members' benefits should be secure, since the scheme will have had to comply regularly with asset, liability and solvency regulations. However, the only examples in Europe where defined benefit occupational pension schemes are regulated as insurance companies are Pensionskassen in Germany and (to some extent) Pension Funds in Belgium. Because of the costs involved, Pensionskassen are only provided by some of the larger employers, covering a minority of employees, and in Belgium defined contribution schemes are becoming increasingly popular, thus reducing the regulatory burden.

In most cases, where insurance company regulations do not apply, the level of insecurity can be controlled by the procedures mentioned in the introduction. Initial registration, ongoing regulation and insolvency insurance are discussed separately.

2.1 Registration

Even though some EU countries have compulsory pension provision that results in adequate replacement levels[4] for all but the highly paid, most still recognise the need to encourage saving and, in particular, saving for retirement. Consequently, it is common for people to be able to defer paying tax on contributions to, and investment returns in, approved pension arrangements. In order to benefit from this, most EU countries require that employers who establish occupational pension schemes should register them with a supervisory authority, and that they should be set up in a particular way, and satisfy certain regulations regarding the benefits they provide. For example, in the UK pension scheme must be set up under Trust Law, whereas in the Netherlands they are normally set up as a Foundation. These requirements have in common that the pension scheme is established as a separate legal entity from the employer, thus introducing the possibility of some independence in the pension scheme's decision making. However, until the 1995 Pensions Act it was frequently the case in the UK that the Trustees of pension schemes tended to be appointed by, and often from amongst the senior management of, the employer. Since the Goode Report[5] and the passage of the 1995 Pensions Act, a Trustee body is expected to have at least 1/3rd member representation. In other countries, such as the Netherlands and Denmark, equal representation is required.

Another consequence of establishing the scheme separately from the employer is that a separate investment fund is accumulated, which can reduce the risk members face in the event of an employer's insolvency. Although book reserved schemes are still the

[4] Replacement level, the ratio of retirement income to final salary, is one way of measuring the adequacy of different modes of pension provision.
[5] Report of the Pensions Law Review Committee, 1992, chaired by Prof. R Goode.

most common form of provision in Germany, several countries discourage, or prohibit, their use. Some companies in Germany have established mutual funds to back their book reserves, where the employees have a direct claim on the assets should the employer become insolvent.

As well as ensuring a scheme is set up in an acceptable way, the process of registration can also be used to involve the employees in the establishment of the scheme. This often includes consultation with trade union, or other employee representative, bodies. If carried out properly, this might ensure that employees accept and understand the scheme, and its limitations, reducing problems of communication later on.

The issue of disclosure to members and to regulatory bodies is becoming increasingly important, and is covered in more detail in section 2.2. Many countries have recently reviewed the level of information required at the formative stage, and introduced legislation with echoes of insurance company regulations. For example, the UK now has the equivalent of a 'fit and proper persons' requirement; and in Luxembourg a minimum capital requirement is imposed.

Another requirement that must be met when a pension scheme is initially established is that benefits comply with legislation regarding vesting rights and non-discrimination. Immediate vesting, particularly when combined with indexation, for example, can reduce problems caused by the discrepancy between benefits and expectations, mentioned above.

Apart from reasons of security, registration is also required by the country's Inland Revenue (or equivalent) to limit the extent to which tax can be deferred. This normally works by imposing maximum benefits that the scheme can provide.

2.2 Ongoing regulation

There are several aspects of the ongoing management of funded pension schemes that might be regulated, with the purpose of ensuring that schemes are able to pay the benefits expected by members under all the possible contingencies. These include

a) a minimum funding requirement, which primarily protects a (usually) minimal level of benefit in the event of wind-up;
b) investment controls;
c) disclosure of information;
d) ensuring good management through, for example, regular funding reviews, regular provision of accounts and financial statements and appropriate management and financial control;
e) ensuring that those responsible for the day to day management of the scheme are properly regulated.

These forms of intervention operate more or less effectively, partly because some aspects are driven by governments' need to ensure a certain level of tax revenue, rather than the primary need to ensure members' security.

a) Minimum funding requirements

With a funded scheme, one ongoing requirement might be that the benefits are financed appropriately. With book reserve financing, this usually means that an appropriate reserve is set aside in the sponsoring employer's balance sheet, and that the employer purchases insolvency insurance. However, in Austria, for example, instead of insurance the employer must ear mark assets (up to at least 50% of the value of the liabilities) for the pension scheme and, in the event of insolvency, the members have a prior claim on those assets.

This begs the question, what is an 'appropriate' level of finance. Most countries impose minimum funding requirements at the level of the accrued benefit obligation (ABO). Some countries impose both a calculation method and a basis. In the ordinary course of events, unless an ongoing scheme is quite mature, the level of funding is in some sense academic. The intention behind the regulation is that, should a pension scheme be wound up, there are 'sufficient' assets to provide members with some level of benefit. By applying the minimum funding test at the ABO level the intention is that members' benefits, based on service and salary at the date of closure, should be met. The choice of basis (in particular, the rate of investment return assumed) is crucial in determining how likely it is that schemes that meet the minimum funding target can also meet their members' benefit entitlements. Unless the assets of the pension scheme exactly match the liabilities, there can never be complete certainty[6]. This is one of the reasons that insurance company regulations stipulate that a solvency margin must be held, over and above what might be considered their equivalent of the ABO. Pension scheme regulators could build in implicit solvency margins by prescribing a cautious basis, but it might be better for such measures to be made explicit.

In the UK many actuaries would recommend that pension schemes are funded to 100% of the projected benefit obligation (PBO). This anticipates, to some extent, the costs imposed by a scheme maturing, by spreading the cost over the lifetime of the plan. It also has the advantage of being less sensitive to fluctuations in investment returns than the ABO. However, to use this as a statutory target could result in confusion, since the members might expect that they are entitled to benefits including future salary escalation, in the event of wind up. In addition, it would be harder to justify this calculation method to the Inland Revenue or accounting authorities, since in some respects a part of the PBO is truly a future service liability. Instead, it might be more appropriate to use an indexed benefit obligation, which is broadly what the MFR in the UK amounts to.

Whilst the MFR, in the abstract, might be viewed as a reasonable minimum funding target, in practice it has been less than satisfactory. As has been reported elsewhere, this is partly because it does not meet people's perceptions of what it should deliver, and partly due to its administrative complexity. Also, any funding requirement that is geared toward security in the event of a scheme's closure will introduce a conflict between the long term and short term financing needs of the scheme.

[6] If governments would issue bonds linked to increases in wages, employers could provide revalued career average pension schemes with little risk. Governments are well placed to do this, since part of their income derives from income tax.

Setting a minimum funding requirement raises a further issue in the case of schemes that undershoot the target. Clearly, some guidance must be provided as to how the scheme must plan to increase its fund up to the prescribed minimum funding level. In the USA employers can be permitted to amortise a past service deficit over as long as 30 years, whereas in the UK, even though the MFR is a higher funding target, employers have a maximum of 5 years. These types of difference imply very different levels of security for the members, and very different financing problems for the employer. A longer amortisation period clearly reduces the scheme members' short term security, but introduces a compromise between the short and long term financial obligations of the scheme's Trustees that might enhance the members' longer term security.

b) Asset regulations

Many countries in the EU restrict the investment policy that a pension scheme can pursue. Restrictions range from the relatively light (in the UK there is a 'prudent person' regime, together with a restriction on self-investment) to the quite prescriptive. Interestingly, in those countries where maximum exposures to certain types of investment are prescribed, the aggregate exposure is generally well below the limit, suggesting that prevailing regulations just reflect national practice. There are several reasons why governments choose to regulate the investment portfolios of pension schemes. It can be, for example, a method of ensuring income to the government, through a minimum exposure to government bonds. However, we are concerned with how it can improve members' security.

One way in which security can be improved is for the pension scheme to provide good 'value for money' for the employer. If the assets of the scheme work for the employer in the sense of keeping costs down, the employer is more likely to continue to support the scheme. Requiring a pension scheme to invest largely in government bonds would be expected to militate against this form of security.

On the other hand, government bonds are secure, in the sense that they will provide their expected redemption yield with a high degree of probability, and consequently reduce short-term volatility in funding. Table 1 gives the risk return ratio experienced by pension schemes in several EU countries and the USA, over the period 1984-93.

Table 1
Ranked risk return ratios, for 1984-93[7]

	Average pension fund return	Average standard deviation	Risk/return ratio
Sweden	14.45	8.54	0.59
US	13.47	9.43	0.70
UK	15.48	11.37	0.73
Netherlands	9.53	7.16	0.75
Belgium	11.80	8.94	0.76
Germany	9.38	7.24	0.77
Denmark	9.99	9.39	0.94
Ireland	14.04	13.65	0.97
Spain	13.8	19.91	1.44

Note that those countries with least investment regulation (the USA, UK, Ireland and the Netherlands) appear to do best in terms of what might be considered long-term security and, with the exception of Ireland, also score well in terms of short-term security. Sweden appears to be an exception, but if inflation were taken into account its ranking would fall.

Several studies have suggested that investment controls are, in fact, counter productive, increasing the overall cost of pension provision without significantly reducing the risk[8]. In response to this the EU Green Paper, *Supplementary Pensions in a Single Market*, is proposing that investment regulation should be relaxed to the 'prudent person' norm in 'Anglo Saxon' regulatory regimes.

However, individuals, especially those in defined contribution schemes, are vulnerable to the time period over which they invest and the financial conditions immediately prior to retirement in particular. In some cases, the value of the pension fund might be low, relative to the contributions, and unable to provide a reasonable standard of living in retirement. In defined benefit schemes, investment risks are spread between members and the employer, and across generations, although members are still vulnerable to the effects of poor investment performance. In some countries where defined contribution pension provision is compulsory, such as Chile, the government guarantees a minimum level of investment return. This can be financed by prescribing that a minimum proportion of the assets must be invested in government bonds[9]. In some ways, government sponsored insolvency insurance is a similar measure, but applied to defined benefit schemes.

c) Disclosure to members

Before being able to mitigate the risks faced by pension scheme membership, one needs to be aware of them. In the UK, and probably elsewhere, most individuals have a low level of understanding or knowledge of what retirement provision they can

[7] K De Ryck, 1996, *European Pension Funds*, European Federation for Retirement Provision
[8] For example, E P Davis, 1995, *Pension Funds: Retirement Income Security and Capital Markets, an International Perspective*, Oxford University Press
[9] As discussed in D Miles and A Timmermann, 'Risk Sharing and transition costs in the reform of pension systems in Europe', in *Costing Pension Reform* (to appear).

expect, whether from the state or from their occupational pension scheme[10]. In the wake of the Maxwell scandal, the British government took action to improve disclosure to scheme members and the 1998 Green Paper *A New Contract for Welfare* acknowledges the need to improve the general level of understanding about pensions. In fact, possibly due to the tradition of 'freedom, with publicity' under which UK insurance legislation developed in the past, the UK seems to have a high degree of disclosure, with formal prescription of minimum disclosure stemming from the 1988 Pensions Act. Of course, it is more difficult to legislate for people to read and understand the literature they are given.

An alternative, or additional, means of providing some dissemination of information to scheme members is through employee representation. This is more common in continental Europe than in the UK, where the 1995 Pensions Act required member representation of 1/3rd the Trustee body. Previously there had been no such requirement. Elsewhere in the EU it is common to have at least 50% employee representation on the boards responsible for the management and administration of pension schemes; in Spain employees must be in the majority. However, the motivation behind the representation is significantly different.

In continental Europe, supplementary pension arrangements have often developed through a combination of paternalism and collective bargaining. This so called 'social contract' has resulted in pensions and related insurance and health care benefits becoming important parts of negotiations between management and labour. Consequently, the representation on pension scheme boards of management tends to be drawn from trade union or other representative employee group, rather than directly from the membership of the scheme. Thus it is possible that, whilst their interests should coincide with those of the scheme members, they might also have other priorities. This could result in a failure of disclosure, and actions taken against the wishes of the membership, despite their apparent representation.

A further tool is to make pension scheme provision and/or membership compulsory. Given the complexity of many retirement benefit systems the potential for individuals to make the wrong decision is so great that their welfare might be best protected by limiting the available choice. This is one of the motives behind the introduction of stakeholder pension schemes in the UK, where the government is currently consulting on making membership of occupational pension schemes compulsory. Some European countries have gone a step further and made provision of defined benefit pension schemes by the employer (quasi) compulsory. Note that defined benefit schemes have high administration costs, particularly for small employers, and in countries where provision is compulsory most coverage is through industry wide arrangements. One of the possible advantages of this form of provision is discussed in section 2.3.

Disclosure should go beyond providing general information about the funding level and contributions paid to the scheme. For individuals to understand what their entitlements are under the various contingencies that could befall them, regular benefit statements are essential. If a benefit statement was combined with a statement

[10] Report of the Director General's Inquiry into Pensions, July 1997, Office of Fair Trading, Volume II

of the scheme's funding level in relation to the minimum funding requirement, this could provide quite powerful information.

d) General supervision

Insurance company regulations impose a requirement to produce regular data to enable regulators to assess solvency levels and to monitor financial and management probity. If data is inadequate, then regulators can intervene in the insurance company's management. The intention is to ensure the protection of policyholders, with whom the insurer has a contract. In addition, accounting regulations and rating agencies ensure that data is provided to shareholders, who can use the stock market to signal their view of an insurance company's management standards.

Whilst some of this framework might be applicable to pension schemes, and indeed, in some EU countries it is applied to pension schemes, there are significant differences between insurance companies and defined benefit pension schemes:

1. insurance companies are providers of financial services, whereas pension schemes (in most cases[11]) are consumers;
2. insurance companies have a contractual relationship with their policyholders, whereas the contractual relationship covering a pension scheme will be between the employee and the employer;
3. insurance companies guarantee nominal benefits, whereas pension schemes provide benefits based on levels of pay;
4. policies issued by insurance companies are usually for fixed premiums, whereas employers are often able to adjust the contribution they pay to a pension scheme;
5. pension schemes have no shareholders, except, perhaps, in the mutual sense[12], but do have the backing of the sponsoring employer(s);
6. insurance companies are profit making organisations, whereas pension schemes are not.

These differences do not necessarily mean that no regulation is required for pension schemes, but that perhaps a different model from the insurance regime would be more appropriate. For example, the Trustees (or equivalent) of a pension scheme are not expected to be experts, unlike the management of an insurance company. Trustees are permitted to delegate tasks to experts, such as fund managers and pay roll administrators, who might already be subject to regulation (such as the Financial Services Act in the UK) and whose performance is likely to be monitored by consultants employed by the Trustees.

The extent of regulation imposed on established pension schemes varies throughout the world. The heaviest burden is placed on those schemes that are regulated as insurance companies and, as has been mentioned, employers are becoming increasingly reluctant to provide pensions under these arrangements. In some countries, particularly those with a high level of compulsory cover, ongoing regulation is minimal. However, it is usual for registered pension schemes to have to provide annual accounts to the regulator.

---

[11] In the Netherlands, some pension funds operate fund management services for unrelated pension schemes.

[12] In some countries pension schemes are established as non profit making organisations and in Luxembourg the beneficiaries are considered the shareholders.

e) Professional Advisors

We should briefly mention the contribution skilled professionals make to ensuring the security of pension scheme members. Most countries require that, when a pension scheme valuation is carried out, it is done by a Fellow of the Institute or Faculty of Actuaries, or equivalent professional. Similarly, when pension schemes assets are invested, the investment manager should be appropriately qualified. In the UK, investment managers are subject to separate regulation. These are the people to whom the 'fit and proper' persons insurance company regulation would apply, and it is essential that the Trustee body has procedures in place for monitoring their performance.

2.3 Insolvency Insurance

Brief details of the compulsory insolvency insurance arrangements and minimum funding requirements found in the EU and USA are given in the appendix. This section only considers how insolvency insurance, when supplemented by the regulatory provision described in sections 2.1 and 2.2, adds to members' security.

Those countries in Europe that insist that pension schemes purchase insolvency insurance do so only for those schemes that are book reserved. Table 2 summarises the position. Where insolvency insurance is provided, it should be noted that there might be limits to the cover. For example, in Germany, cover is only provided up to 1½ times the social security ceiling (approximately £34,000), and in the USA the maximum pension the PBGC will pay is approximately £20,000 pa.

Table 2
Summary of insolvency provision for pension schemes in the EU

	Main type[a]	Financing	Provision in the event of insolvency of the sponsor and underfunding of scheme
Austria	DB[b]	Mostly funded, but some book reserves	Book reserve pension beneficiaries are preferential creditors for earmarked assets
Belgium	DB[c]	Funded	
Denmark	DC[d]	Funded	
Finland	DB	Funded, or insurance arrangement	Insolvency insurance compulsory for TEL[e]
France	DB	PAYG, with some top up funding	Costs met by remaining employers in scheme.
Germany	DB	Funded (mainly book reserves)	Insolvency insurance compulsory in case of book reserves
Greece	DB	Funded	
Ireland	DB	Funded	
Italy	DC[d]	Funded	
Luxembourg	DB	Mainly book reserves, some funded	Insolvency insurance compulsory in case of book reserves
Netherlands	DB	Funded	For sector wide schemes the cost will be met by remaining sponsoring employers.
Portugal	DB	Funded	
Spain	DC[d]	Funded	
Sweden	DB	Funded or book reserve	Credit insurance in case of book reserves
UK	DB	Funded	Only in case of fraud[e]

Notes:
(a) DB is defined benefit and DC is defined contribution, or money purchase.
(b) It is notable that Austria is the only country that permits book reserve schemes without insisting on the purchase of insolvency insurance. However, the replacement ratios provided by compulsory provision in Austria are relatively high, only dropping below 50% at the equivalent of £40,000.
(c) In Belgium, occupational pension schemes are regulated in the same way as insurance companies.
(d) Defined contribution schemes are, buy their nature, always fully funded.
(e) Although employers contribute to a fund for the compulsory TEL scheme, the assets are loaned back to employers, so that it is closer to book reserving than normal funding.
(f) This 'insurance' is funded by an after the event levy imposed on the pension scheme industry.

Significant parts of the regulatory regime described in section 2.2 rest on the existence of a separate fund of assets, so that employees can make decisions based on the nature of the underlying investments, the degree of funding and the contribution rates paid by the employer. As was suggested in the introduction, in an ideal world, employees could use this information together with information about the financial security of the sponsoring employer to assess the relative values of different employment opportunities. The existence of insolvency insurance, particularly where premiums are

not market related, would be at best irrelevant, and at worst it could distort the decision making process.

However, in a world where employees are less able to assess the virtues of competing employers and their pension schemes, there might be a role for insolvency insurance. In the USA, which has a pension regime quite similar to that in the UK, in 1974 the Pension Benefit Guarantee Corporation (PBGC) was established to underwrite the benefits of occupational pension schemes. Its existence has not removed the need for regulation and, in fact, because of difficulties with the establishment of the PBGC, the regulatory regime in the USA is becoming increasingly expensive, to the extent that there has been a drift away from defined benefit pension provision.

There are several lessons to be learned from the experience of the PBGC, but perhaps most important of all has been that an insurer must be careful of the baggage it picks up on the way. Many of the financial difficulties experienced by the PBGC have arisen as a result of weak regulation and policy design in its early years; conflicting funding aims between the PBGC and the Internal Revenue; and the existence of large fixed benefit schemes that give rise to huge unfunded liabilities each time a decision is taken to revalue the fixed rate.

With book reserving, disclosure of funding levels or contributions becomes irrelevant, and the existence of insolvency insurance fills the gap. Effectively, purchasing the insurance is an alternative to the funding decision. However, in none of the cases of insolvency insurance we discuss, is the premium paid for insurance calculated on a market related basis, taking into account the credit risk of the employer. Thus it is not possible to make a direct comparison between the two forms of financing. Indeed, suppose we make a comparison between two employers, one funding a pension scheme in the UK mode, and another purchasing insolvency insurance in the German mode, say. Then the cost to the former is the cost of providing the benefits, as calculated by the actuary with due regard to the position of the scheme. The cost to the latter is related to the costs incurred by the insolvency insurer over the recent past: the PSVaG is funded on a PAYGo basis, which is a function of insolvencies and inadequate investments elsewhere in the market, rather than anything to do with individual companies.

The Netherlands and France have an alternative way of providing for employees in the event of employer insolvency. In France, most employees are covered by one (or both) of two occupational pension schemes, AGIRC or ARRCO, which cover employees from a variety of industries. The schemes offer similar benefits, but cover different salary levels, financed on a Pay as You Go basis. If a company becomes bankrupt, its employees remain in their scheme and the cost of paying their accrued benefits will be met by the remaining contributing employers. A similar arrangement occurs in the sector wide schemes in the Netherlands, although the benefits are provided on a funded basis. Effectively, in these two countries, employers are grouping together to provide themselves with mutual insurance. However, whilst this seems as though employers have reached a high degree of accord with one another, in fact they have little choice. In France it is compulsory to provide occupational pensions and virtually all employers, apart from the largest, do so through schemes that cover a variety of industries or sectors. In the Netherlands, it is difficult for

employers not to join a sector wide scheme, where one is available and so, effectively, employers have no choice in the matter[13].

3 Conclusion

With the level of regulation of defined benefit occupational pension schemes in most EU countries, it is possible, although perhaps unlikely, that an employer could become bankrupt when its pension scheme has insufficient assets to meet its accrued liabilities. With minimum funding and disclosure regulations in place and properly enforced, the likelihood of such an event occurring when a pension scheme has a significant deficit becomes even more unlikely. Since it doesn't seem that a voluntary market for insolvency insurance exists in the UK, the government must decide whether it feels it is reasonable for individual scheme members to bear this risk, or whether it should remove or reduce the risk further through some form of insurance.

As the experience in the USA has demonstrated, there are risks associated with insolvency insurance. It might turn out to be superfluous or counterproductive if effective safeguards already exist and it could provoke moral hazard. If premiums are not priced in a competitive market, the system can produce cross-subsidies from financially healthy to weak firms, causing a reduction in economic efficiency. Indeed, in the USA the PBGC is partly viewed as a convenient way of subsidising 'sunset' industries.

An alternative to insurance could be to improve disclosure, which in some EU countries is achieved through formal or informal collective bargaining, rather than direct communication with members, which is the norm in the UK. Put alongside well chosen funding requirements, these tools could reduce, or even remove, the need for insurance.

Ensuring that those responsible for the good administration of a pension scheme are legally independent from the sponsoring employer can also help ensure each pension scheme's financial integrity. By imposing a well thought out and consistent regulatory regime, so that non-professional trustees, for example, can understand the limitations in which they can operate, and so that pension scheme members can understand their entitlements and have confidence that they will be met, the need for insolvency insurance can be reduced. However, such regulation is likely to impose costs on employers that some might feel unable to bear. In particular, small employers, who collectively employ the majority of the workforce in the UK, could be disinclined to provide defined benefit pension provision for their employees. Because of the additional risks faced by members of defined contribution pension schemes, this would be an unfortunate consequence of a regime intended to reduce risk.

One alternative might be to encourage industry wide provision. There are significant economies of scale that can be achieved in defined benefit provision. Some industries in the UK already have schemes open to a wide selection of employers and sector wide schemes cover over 60% of employees in the Netherlands. Although this form of provision can involve cross subsidies, supporters of sector wide schemes argue that, by making pension provision part of the collective bargaining process, benefit

[13] The ECJ case C-219/97 Maatschappij Drijvende Bokken BV v. Stichting Pensioenfonds voor de Vervoer-en Havenbedrijven.

standards and contribution rates should remain consistent with economic circumstances. The risks of selection bias and moral hazard are thus regulated by a process of openness and disclosure.

If it is felt desirable that scheme members should have complete certainty that their benefits will be met, some form of insurance seems essential. The choice lies between a more expensive regulatory regime and no insurance; less regulation and insolvency insurance; or mutual insurance through industry wide pension schemes. Unless such insurance can become affordable in the market place, there is certainly a case for government to become involved, at least up to a certain level of benefit. Such a commitment need not be expensive, provided appropriate regulation is in place.

Appendix

Second Pillar Insolvency Insurance in the EU and the USA[14]

A1 Introduction

Compulsory insolvency insurance schemes for defined benefit occupational pension schemes exist in certain countries only - the USA, Germany, Japan, the UK (only recently, and in the case of fraud only), Sweden, Finland, Canada (Province of Ontario) and Switzerland. One purpose of these systems is to face crisis situations, such as occurred recently in the UK with regards to the Maxwell affair. Here we summarise the provisions in place to protect pension scheme members in the event of an employer's insolvency, including insolvency insurance arrangements, that cover second pillar pension schemes in the European Union and the USA.

A2 Insolvency Provisions in the European Union

Austria

Pension schemes in Austria are usually provided through Pensionskassen, with book reserve arrangements next most frequent.

Pensionskassen are covered by the 1990 Pensions Act, which set out their establishment as joint stock companies with specific requirements as to minimum paid-up share capital and ratio of equity to technical reserves. Although most new schemes are defined contribution, it is possible for Pensionskassen to provide defined benefits. Pensionskassen are regulated by the Ministry of Finance, which sets out stringent disclosure and reporting requirements, subject to review by an internal and external actuary.

Book Reserve schemes cover 40% of pension scheme members. Allocations to the book reserve are calculated using a discount rate of 6%. Unusually, companies with book reserve schemes are not required to purchase insolvency insurance. Instead, the Company Pensions Act 1990 stipulates that at least 50% of a company's book reserve must be covered by a direct company holding of government bonds and, in the event of the company's insolvency the pension scheme members have a prior claim to these assets.

The 10% of pension scheme members whose benefits are provided by direct insurance have contracts with the insurer, rather than the employer, and consequently their benefits are effectively regulated under insurance company legislation.

Belgium

In Belgium direct insurance schemes provide defined contribution arrangements, which traditionally have provided a minimum guaranteed rate of return, together with variable bonuses. Since 1 July 1999 the maximum guarantee permitted has been 3.75%.

[14] The information in this appendix was gathered from a variety of sources, but in particular, Watson Wyatt, 2000, *Benefits Report, Europe, USA and Canada, 2000.*

Non insured plans must be funded (that is, book reserve and pay as you go arrangements are not allowed) and must be established either as a non profit making organisation or as a mutual insurance company. In either case they are approved and regulated by the Insurance Control Authorities. A minimum funding requirement based on an ABO calculation is imposed, using 6% interest and prescribed mortality tables.

Denmark

In Denmark, virtually all provision in the second pillar is provided by Defined Contribution plans.

Finland

In Finland there is a high level of compulsory coverage. The most common arrangement is the TEL scheme, for wage earners and salaried employees. This is a partly funded system. Employers pay contributions to an insurance company, or to a pension fund or foundation, which can lend assets back to the employer. The pensions provided by insurance companies are guaranteed against the failure of any single institution by a 100% mutual guarantee. In the case of funds or foundations, employers who have taken loan backs must purchase credit insurance to cover the risk of employer insolvency or failure of the pension fund or foundation.

All pension arrangements (funds, foundations or pension insurance companies) are supervised and co-ordinated by the Central Pension Security Institution (CPSI), which passed the responsibility for the employer's insolvency insurance to a new insurance company, Garantia Ltd, in 1994. The insurance arrangements do not depend on governmental financial backing but only on premium income and recoveries of assets from insolvent companies. The premium charged is determined by the amount of the loan taken by the employer, the employer's financial health, and the value of any guarantees provided by the employer to Garantia.

Supplementary pensions are usually offered by insurance schemes, which comply with the EU Life Directives on funding and solvency standards, although they can be offered through pension funds or foundations. These schemes provide top up the basic TEL coverage for high paid employees, and are quite lightly regulated.

France

In France there is no insolvency insurance per se. Occupational pensions are mandatory to quite a high level of pay and financed by Pay as You Go schemes, which are independent of the financial health of individual companies. The pension benefits are guaranteed through the size of institutions: if one company out of a number of companies fails to pay the pension benefits then the others will have to meet its accrued pension costs.

Supplementary schemes are encouraged in principle, although no consensus has been reached as to how they should be provided.

Germany

Approximately 57% of the liabilities for accrued occupational pensions are financed through book reserve schemes in Germany. Allocations to the book reserve are calculated using a discount rate of 6%. The schemes represented by these assets are only lightly regulated, but there is a requirement for the employer to purchase insolvency insurance. The insurance is provided by the Pensions Sicherung Verein aG (PSVaG), a mutual fund set up and organised by the employers and life insurance companies. Should an employer become insolvent then the PSVaG assumes the liabilities arising from the book reserves and, when it is time to pay out the pension benefit, the PSVaG buys an annuity directly from an insurer.

The premium rates charged by the PSVaG are fixed with regard to two criteria. Firstly, to protect the full actuarial liability in respect of all uncovered benefits arising each year (long term perspective), and secondly, to provide sufficient funds to meet the benefits payable in that year (short term perspective). The 1999 premium rate was 0.28% of vested liabilities.

Greece

Most occupational pension funds in Greece are insured in deposit administration contracts without any legal requirement of a minimum funding standard.

Ireland

In Ireland, pension schemes are established under Trust Law and their assets are separate from the employer who sponsors the scheme. External investment managers usually manage the investments, and the assets are normally either invested in directly purchased stocks and shares, a pooled unit trust, or deferred annuities, depending largely on the size of the scheme.

Since the passage of the 1990 Pensions Act all (private sector) defined benefit pension schemes have had to be funded and to comply with minimum funding requirements. The target is for all schemes to be at least 100% funded, based on an indexed benefit obligation (IBO) (accrued benefits since January 1991, with 4% pa, or price inflation, indexation), by January 2001. The funding requirements are monitored and assessed every three years by the scheme's actuary. If a scheme fails to meet the funding standard then the trustees have to submit a 'funding proposal' to the Pension Board which sets out how the scheme will cover the shortfall in the next 3½ years. Without such a proposal the Pension Board may require the trustees to modify the scheme so that the funding standard can be achieved. Such a modification could vary from decreasing the pension benefits to the wind-up of the scheme.

There is no formal compensation scheme in Ireland for the eventuality that the employer becomes insolvent.

Italy

Compulsory provision in Italy provides high replacement ratios, even at relatively high rates of pay. Since 1993, all new entrants to pension plans providing benefits above the compulsory level must be covered by defined contribution arrangements.

Luxembourg

Most employers in Luxembourg use the book reserve method to finance their pension funds and since 1 January 2000 there has been an obligation for the employer to purchase insolvency insurance.

A small number of employers use direct group insurance, where the mortality rates, interest rates and expense loadings used in the calculation of premiums and reserves are controlled by the Insurance Supervisory Board.

It is possible to provide pension benefits through a pension fund, which must be established as a separate legal entity from the employer, but until recently this has been rare because of tax legislation. Pension funds will have to maintain a minimum funding requirement on a prescribed basis that has not yet been determined.

Netherlands

In the Netherlands pension funds are usually financed through group insurance contracts or self-administered funds. Both are supervised by the Verzekeringskamer (Insurance Chamber), which sets funding standards for pension schemes and insured schemes. Although the level of funding need only be tested by an actuary every 5 years, in practice the calculation is carried out annually since an annual, audited, report must be made to the Insurance Chamber setting out the financial position of the fund. The interest rate used for the calculation can be no greater than 4%, with no provision for future salary growth or withdrawal.

If a pension scheme is underfunded then it must produce a strategic plan of how it will remove the deficit during a period of no longer than five years.

The majority of employees who are covered by occupational pension schemes are in sector wide schemes, funded by a flat rate premium applied to all members, regardless of past service or age. Sector wide schemes provide a form of mutual insurance in the event of an individual employer's insolvency.

Portugal

Although compulsory pension provision provides high replacement levels, occupational pension schemes are still fairly common. They are usually financed through pension funds or direct insurance, since book reserve or PAYGo methods are less tax efficient. The supervisory body, the Instituto Seguros de Portugal (ISP), oversees the basis (4½% and no allowance for salary growth) and method of calculation for the minimum funding requirement (ABO), which must be conservative (and not a best estimate). By the end of 1999 any deficit must have been fully amortised.

Spain

Since 1995 a new insurance law prohibited the book reserving funding method, except for banks, insurance companies and stockbroker houses. All pension plans have to be funded independently from the sponsor either through insurance or a Pension Fund, which are legal entities created to manage the assets of qualified pension plans, supervised by the Ministry of Finance.

Defined benefit pension plans, and defined contribution plans that guarantee minimum investment returns, have to establish a minimum solvency requirement (of the larger of mill Ptas and 4% of the actuarial liabilities) in addition to meeting their actuarial liabilities. Virtually all plans that have been opened have been defined contribution.

Sweden

The Swedish social security scheme provides a relatively high replacement level for low earners only, so there is a need for the private occupational pension benefits. This is largely provided by two nationwide forms of contract, which have arisen as a result of collective bargaining: the ITP plan, which is a defined benefit arrangement, for government and salaried employees; and the SAF-LO plan for wage earners.

ITP retirement benefits can be secured in one of three ways: either with an insurance contract with a mutual insurance company, the SPP; by book reserves together with compulsory credit insurance, through the FPG/PRI system; or through a pension foundation (Stiftelse). The book reserves and pension foundations are funded on a tariff basis that uses 3¾% gross interest, or 3% gross interest if the scheme guarantees inflation increases; the cost of the SPP insurance is based on 3% interest.

The FPG will provide credit insurance only on the condition that the employer is credit worthy[15]. Usually, credit insurance is taken out for a period of 5 years and, at the end of the period, it can be terminated by either party. The FPG can terminate the insurance earlier if the company appears unable to meet its obligations. Generally only medium or large companies use this method: small companies are only insured if sufficient collateral can be provided to cover their credit insurance.

The insurance premium is set as a percentage of the company's pension 'debt', or book reserve, in the previous year. The premium has to be the same regardless of the employer's industry, occupation, or financial standing.

SAF-LO is a new defined contribution plan, which replaced the previous, defined benefit, arrangement.

United Kingdom

The UK system has a low level of state scheme provision and a large complementary sector.

[15] Companies considered financially weak are required to provide some kind of security to the FPG for their liabilities.

In order to be approved for tax purposes, pension schemes must be established under Trust Law and the assets invested separately from the employer. The Pensions Act 1995 set a Minimum Funding Requirement (MFR) for all tax-approved defined benefit schemes, based on an IBO (the ABO together with limited price indexation). Schemes that do not meet the MFR must put in place a funding plan to achieve it within five years. If the scheme's assets represent less than 90% of the MFR, this level of funding must be achieved within one year.

The 1995 Pensions Act also established a provision to compensate scheme members should their employer become insolvent when their pension scheme is less than 90% funded on an MFR basis due to fraud. The cost of the insurance is to be met by an after the event levy imposed on the remaining defined benefit pension schemes.

A3 The USA

The 1974 Employee Retirement Income Security Act (ERISA) established the Pensions Benefit Guarantee Corporation (PBGC) to provide termination insurance for defined benefit pension schemes, since it felt it was essential to protect participants and their beneficiaries against loss of benefits arising from a complete or partial plan termination. The PBGC is self-financed, deriving its funds from the following sources: premium income from those it insures, investment income, charges on the insolvent employer's assets and money borrowed from the US Treasury. Single-employer pension plans pay a basic flat-rate premium of $19 per participant per year, and underfunded pension plans pay an additional variable-rate charge of $9 per $1,000 of unfunded vested benefits. The premium for the smaller multi-employer program is $2.60 per participant per year.

The PBGC has introduced various provisions in order to protect itself from adverse selection by plan sponsors. For example, benefit increases awarded within three years of the plan's termination are not covered, and there is a cap on the level of pension paid[16]. Minimum funding standards are based on an ABO, but allow the amortisation of unfunded liabilities over a prolonged period of time (usually 30 years).

[16] For plans with a 2000 termination date, the maximum guarantee is $38,659.08 yearly for a single-life annuity beginning at age 65. The maximum is adjusted downward for retirees younger than age 65.

CITY University

DEPARTMENT OF ACTUARIAL SCIENCE AND STATISTICS

Actuarial Research Papers since 1995

70. Huber P. A Review of Wilkie's Stochastic Investment Model. January 1995. 22 pages. ISBN 1 874 770 70 0

71. Renshaw A.E. On the Graduation of `Amounts'. January 1995. 24 pages. ISBN 1 874 770 71 9

72. Renshaw A.E. Claims Reserving by Joint Modelling. December 1994. 26 pages. ISBN 1 874 770 72 7

73. Renshaw A.E. Graduation and Generalised Linear Models: An Overview. February 1995. 40 pages. ISBN 1 874 770 73 5

74. Khorasanee M.Z. Simulation of Investment Returns for a Money Purchase Fund. June 1995. 20 pages. ISBN 1 874 770 74 3

75. Owadally M.I. and Haberman S. Finite-time Pension Fund Dynamics with Random Rates of Return. June 1995. 28 pages. ISBN 1 874 770 75 1

76. Owadally M.I. and Haberman S. Stochastic Investment Modelling and Optimal Funding Strategies. June 1995. 25 pages. ISBN 1 874 770 76 X

77. Khorasanee M.Z Applying the Defined Benefit Principle to a Defined Contribution Scheme. August 1995. 30 pages. ISBN 1 874 770 77 8

78. Sebastiani P. and Settimi R. Experimental Design for Non-Linear Problems. September 1995. 13 pages. ISBN 1 874 770 78 6

79. Verrall R.J. Whittaker Graduation and Parametric State Space Models. November 1995. 23 pages. ISBN 1 874 770 79 4

80. Verrall R.J. Claims Reserving and Generalised Additive Models. November 1995. 17 pages. ISBN 1 874 770 80 8

81. Nelder J.A. and Verrall R.J. Credibility Theory and Generalized Linear Models. November 1995. 15 pages. ISBN 1 874 770 81 6

82. Renshaw A.E., Haberman S. and Hatzopoulos P. On The Duality of Assumptions Underpinning The Construction of Life Tables. December 1995. 17 Pages. ISBN 1 874 770 82 4

83. Chadburn R.G. Use of a Parametric Risk Measure in Assessing Risk Based Capital and Insolvency Constraints for With Profits Life Insurance. March 1996. 17 Pages. ISBN 1 874 770 84 0

84. Haberman S. Landmarks in the History of Actuarial Science (up to 1919). March 1996. 62 Pages. ISBN 1 874 770 85 9

85. Renshaw A.E. and Haberman S. Dual Modelling and Select Mortality. March 1996. 30 Pages. ISBN 1 874 770 88 3

86. Booth P.M. Long-Term Care for the Elderly: A Review of Policy Options. April 1996. 45 Pages. ISBN 1 874 770 89 1

87. Huber P.P. A Note on the Jump-Equilibrium Model. April 1996. 17 Pages. ISBN 1 874 770 90 5

88. Haberman S and Wong L.Y.P. Moving Average Rates of Return and the Variability of Pension Contributions and Fund Levels for a Defined Benefit Pension Scheme. May 1996. 51 Pages. ISBN 1 874 770 91 3

89. Cooper D.R. Providing Pensions for Employees with Varied Working Lives. June 1996. 25 Pages. ISBN 1 874 770 93 X

90. Khorasanee M.Z. Annuity Choices for Pensioners. August 1996. 25 Pages. ISBN 1 874 770 94 8

91. Verrall R.J. A Unified Framework for Graduation. November 1996. 25 Pages. ISBN 1 874 770 99 9

92. Haberman S. and Renshaw A.E. A Different Perspective on UK Assured Lives Select Mortality. November 1996. 61 Pages. ISBN 1 874 770 00 X

93. Booth P.M. The Analysis of Actuarial Investment Risk. March 1997. 43 Pages. ISBN 1 901615 03 0

94. Booth P.M., Chadburn R.G. and Ong A.S.K. Utility-Maximisation and the Control of Solvency for Life Insurance Funds. April 1997. 39 Pages. ISBN 1 901615 04 9

95. Chadburn R.G. The Use of Capital, Bonus Policy and Investment Policy in the Control of Solvency for With-Profits Life Insurance Companies in the UK. April 1997. 29 Pages. ISBN 1 901615 05 7

96. Renshaw A.E. and Haberman S. A Simple Graphical Method for the Comparison of Two Mortality Experiences. April 1997. 32 Pages. ISBN 1 901615 06 5

97. Wong C.F.W. and Haberman S. A Short Note on Arma (1, 1) Investment Rates of Return and Pension Funding. April 1997. 14 Pages. ISBN 1 901615 07 3

98. Puzey A S. A General Theory of Mortality Rate Estimators. June 1997. 26 Pages. ISBN 1 901615 08 1

99. Puzey A S. On the Bias of the Conventional Actuarial Estimator of q_x. June 1997. 14 Pages. ISBN 1 901615 09 X

100. Walsh D. and Booth P.M. Actuarial Techniques in Pricing for Risk in Bank Lending. June 1997. 55 Pages. ISBN 1 901615 12 X

101. Haberman S. and Walsh D. Analysis of Trends in PHI Claim Inception Data. July 1997. 51 Pages. ISBN 1 901615 16 2

102. Haberman S. and Smith D. Stochastic Investment Modelling and Pension Funding: A Simulation Based Analysis. November 1997. 91 Pages. ISBN 1 901615 19 7

103. Rickayzen B.D. A Sensitivity Analysis of the Parameters used in a PHI Multiple State Model. December 1997. 18 Pages. ISBN 1 901615 20 0

104. Verrall R.J. and Yakoubov Y.H. A Fuzzy Approach to Grouping by Policyholder Age in General Insurance. January 1998. 18 Pages. ISBN 1 901615 22 7

105. Yakoubov Y.H. and Haberman S. Review of Actuarial Applications of Fuzzy Set Theory. February 1998. 88 Pages. ISBN 1 901615 23 5

106. Haberman S. Stochastic Modelling of Pension Scheme Dynamics. February 1998. 41 Pages. ISBN 1 901615 24 3

107. Cooper D.R. A Re-appraisal of the Revalued Career Average Benefit Design for Occupational Pension Schemes. February 1998. 12 Pages. ISBN 1 901615 25 1

108. Wright I.D. A Stochastic Asset Model using Vector Auto-regression. February 1998. 59 Pages. ISBN 1 901615 26 X

109. Huber P.P. and Verrall R.J. The Need for Theory in Actuarial Economic Models. March 1998. 15 Pages. ISBN 1 901615 27 8

110. Booth P.M. and Yakoubov Y. Investment Policy for Defined Contribution Pension Scheme Members Close to Retirement. May 1998. 32 Pages ISBN 1 901615 28 6

111. Chadburn R.G. A Genetic Approach to the Modelling of Sickness Rates, with Application to Life Insurance Risk Classification. May 1998. 17 Pages. ISBN 1 901615 29 4

112. Wright I.D. A Stochastic Approach to Pension Scheme Funding. June 1998. 24 Pages. ISBN 1 901615 30 8

113. Renshaw A.E. and Haberman S. Modelling the Recent Time Trends in UK Permanent Health Insurance Recovery, Mortality and Claim Inception Transition Intensities. June 1998. 57 Pages. ISBN 1 901615 31 6

114. Megaloudi C. and Haberman S. Contribution and Solvency Risk in a Defined Benefit Pension Scheme. July 1998. 39 Pages ISBN 1 901615 32 4

115. Chadburn R.G. Controlling Solvency and Maximising Policyholders' Returns: A Comparison of Management Strategies for Accumulating With-Profits Long-Term Insurance Business. August 1998. 29 Pages ISBN 1 901615 33 2

116. Fernandes F.N. Total Reward - An Actuarial Perspective. August 1998. 25 Pages. ISBN 1 901615 34 0

117. Booth P.M. and Walsh D. The Application of Financial Theory to the Pricing of Upward Only Rent Reviews. November 1998. 23 Pages. ISBN 1 901615 35 9

118. Renshaw A.E. and Haberman S. Observations on the Proposed New Mortality Tables Based on the 1991-94 Experience for Male Permanent Assurances. February 1999. 40 Pages. ISBN 1 901615 36 7

119. Velmachos D. And Haberman S. Moving Average Models for Interest Rates and Applications to Life Insurance Mathematics. July 1999. 27 Pages. ISBN 1 901615 38 3

120. Chadburn R.G. and Wright I.D. The Sensitivity of Life Office Simulation Outcomes to Differences in Asset Model Structure. July 1999. 58 Pages. ISBN 1 901615 39 1

121. Renshaw A.E. and Haberman S. An Empirical Study of Claim and Sickness Inception Transition Intensities (Aspects of the UK Permanent Health Insurance Experience). November 1999. 35 Pages. ISBN 1 901615 41 3

122. Booth P.M. and Cooper D.R. The Tax Treatment of Pensions. April 2000. 36 pages. ISBN 1 901615 42 1

123. Walsh D.E.P. and Rickayzen B.D. A Model for Projecting the number of People who will require Long-Term Care in the Future. Part I: Data Considerations. July 2000. 37 pages. ISBN 1 901615 43 X

124. Rickayzen B.D. and Walsh D.E.P. A Model for Projecting the number of People who will require Long-Term Care in the Future. Part II: The Multiple State Model. July 2000. 27 pages. ISBN 1 901615 44 8

125. Walsh D.E.P. and Rickayzen B.D. A Model for Projecting the number of People who will require Long-Term Care in the Future. Part III: The Projected Numbers and The Funnel of Doubt. July 2000. 61 pages. ISBN 1 901615 45 6

126. Cooper D.R. Security for the Members of Defined Benefit Pension Schemes. July 2000. 23 pages. ISBN 1 901615 45 4

Statistical Research Papers

1. Sebastiani P. Some Results on the Derivatives of Matrix Functions. December 1995. 17 Pages. ISBN 1 874 770 83 2

2. Dawid A.P. and Sebastiani P. Coherent Criteria for Optimal Experimental Design. March 1996. 35 Pages. ISBN 1 874 770 86 7

3. Sebastiani P. and Wynn H.P. Maximum Entropy Sampling and Optimal Bayesian Experimental Design. March 1996. 22 Pages. ISBN 1 874 770 87 5

4. Sebastiani P. and Settimi R. A Note on D-optimal Designs for a Logistic Regression Model. May 1996. 12 Pages. ISBN 1 874 770 92 1

5. Sebastiani P. and Settimi R. First-order Optimal Designs for Non Linear Models. August 1996. 28 Pages. ISBN 1 874 770 95 6

6. Newby M. A Business Process Approach to Maintenance: Measurement, Decision and Control. September 1996. 12 Pages. ISBN 1 874 770 96 4

7. Newby M. Moments and Generating Functions for the Absorption Distribution and its Negative Binomial Analogue. September 1996. 16 Pages. ISBN 1 874 770 97 2

8. Cowell R.G. Mixture Reduction via Predictive Scores. November 1996. 17 Pages. ISBN 1 874 770 98 0

9. Sebastiani P. and Ramoni M. Robust Parameter Learning in Bayesian Networks with Missing Data. March 1997. 9 Pages. ISBN 1 901615 00 6

10. Newby M.J. and Coolen F.P.A. Guidelines for Corrective Replacement Based on Low Stochastic Structure Assumptions. March 1997. 9 Pages. ISBN 1 901615 01 4.

11. Newby M.J. Approximations for the Absorption Distribution and its Negative Binomial Analogue. March 1997. 6 Pages. ISBN 1 901615 02 2

12. Ramoni M. and Sebastiani P. The Use of Exogenous Knowledge to Learn Bayesian Networks from Incomplete Databases. June 1997. 11 Pages. ISBN 1 901615 10 3

13. Ramoni M. and Sebastiani P. Learning Bayesian Networks from Incomplete Databases. June 1997. 14 Pages. ISBN 1 901615 11 1

14. Sebastiani P. and Wynn H.P. Risk Based Optimal Designs. June 1997. 10 Pages. ISBN 1 901615 13 8

15. Cowell R. Sampling without Replacement in Junction Trees. June 1997. 10 Pages. ISBN 1 901615 14 6

16. Dagg R.A. and Newby M.J. Optimal Overhaul Intervals with Imperfect Inspection and Repair. July 1997. 11 Pages. ISBN 1 901615 15 4

17. Sebastiani P. and Wynn H.P. Bayesian Experimental Design and Shannon Information. October 1997. 11 Pages. ISBN 1 901615 17 0

18. Wolstenholme L.C. A Characterisation of Phase Type Distributions. November 1997. 11 Pages. ISBN 1 901615 18 9

19. Wolstenholme L.C. A Comparison of Models for Probability of Detection (POD) Curves. December 1997. 23 Pages. ISBN 1 901615 21 9

20. Cowell R.G. Parameter Learning from Incomplete Data Using Maximum Entropy I: Principles. February 1999. 19 Pages. ISBN 1 901615 37 5

21. Cowell R.G. Parameter Learning from Incomplete Data Using Maximum Entropy II: Application to Bayesian Networks. November 1999. 12 Pages ISBN 1 901615 40 5

Department of Actuarial Science and Statistics

Actuarial Research Club

The support of the corporate members

CGU
Government Actuary's Department
Guardian Insurance
Hymans Robertson
KPMG
Munich Reinsurance
PricewaterhouseCoopers
Swiss Reinsurance
Watson Wyatt

is gratefully acknowledged.

ISBN 1 901615 45 4